

Exercise walk-through

33.2

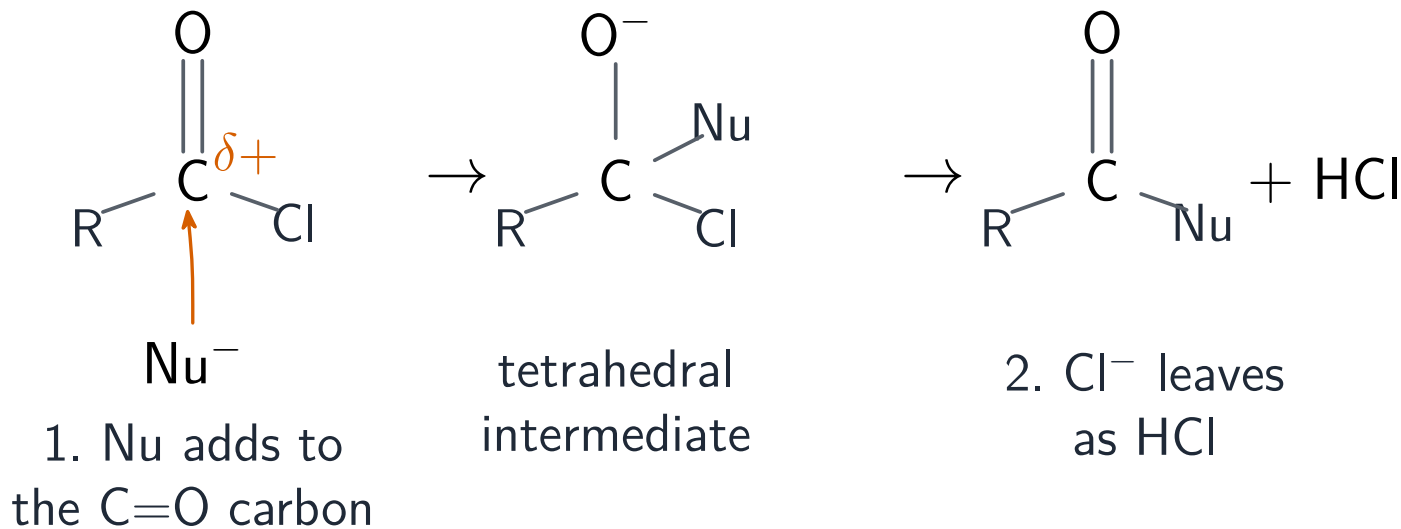
Esters

A-Level Chemistry

The addition–elimination mechanism

All these follow **addition–elimination** :

- a nucleophile **adds** to the $\delta+$ carbonyl carbon
- then HCl is **eliminated** as the C=O reforms

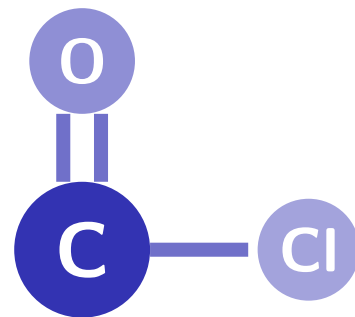


Exam tips

- **Acyl chlorides** are very reactive – learn their products with water (HCl), alcohols (esters), ammonia (amides) and amines.
- Reactivity order of derivatives: **acyl chloride** > **ester** > **amide**.
- Acid strength: electron-withdrawing groups (e.g. Cl) **increase** it – explain via the carboxylate ion.

Check yourself

- 1 Which is most acidic: alcohol, phenol or acid?
- 2 What does an acyl chloride give with ammonia?
- 3 Name the acyl chloride mechanism.
- 4 Which chloride hydrolyses fastest?



Answers 1. the carboxylic acid 2. an amide 3. addition–elimination 4. the acyl chloride

Exercises 2.1·2.2

2.1 Name the ester $\text{CH}_3\text{COOCH}_2\text{CH}_3$.

[1]

2.2 Name the two organic starting materials (an acyl chloride + an alcohol) for ethyl ethanoate.

[2]

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- ethyl ethanoate

2.2 Name the two organic starting materials (an acyl chloride + an alcohol) for ethyl ethanoate.

[2]

2.2

- ethanoyl chloride; ethanol

Exercise 3.1

3.1 The ester HCOOCH_3 is named:

[1]

☐

A methyl methanoate

B methyl ethanoate

C ethyl methanoate

D methanoyl methane

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3.1 A

- $\text{HCOO}-$ is methanoate; $-\text{CH}_3$ is methyl
- methyl methanoate

Exercise 3.2

3.2 Phenyl benzoate is made from benzoyl chloride and:

[1]

☐

A benzene

B phenol

C benzoic acid

D phenylamine

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3.2 Phenyl benzoate is made from benzoyl chloride and:

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A benzene

B phenol

C benzoic acid

D phenylamine

3.2 B

- Phenol + benzoyl chloride
- phenyl benzoate + HCl

Exercise 3.3 (a)

3.3 Methanol reacts with ethanoyl chloride.

(a) Write the equation.

[2]

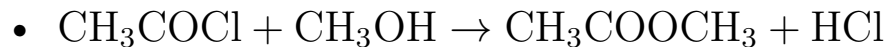
Exercise 3.3 (a)

3.3 Methanol reacts with ethanoyl chloride.

(a) Write the equation.

[2]

(a)



Exercise 3.3 (b)

3.3 Methanol reacts with ethanoyl chloride.

(b) Name the ester formed.

[1]

Exercise 3.3 (b)

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[1]

(b)

- methyl ethanoate

Exercise 3.4

3.4 Draw the structure of propyl methanoate and circle the **ester link**.

[2]

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3.4

- $\text{HCOOCH}_2\text{CH}_2\text{CH}_3$ drawn out; the $-\text{COO}-$ ester link circled

Exercise 3.5 (a)

3.5 Ethanoyl chloride, CH_3COCl , reacts with propan-1-ol.

(a) Write the equation, name the ester formed, and state one observation.

[3]

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(a)

- $\text{CH}_3\text{COCl} + \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_3 + \text{HCl}$; the ester is **propyl ethanoate**; steamy white fumes of hydrogen chloride are seen

Exercise 3.5 (b)

3.5 Ethanoyl chloride, CH_3COCl , reacts with propan-1-ol.

(b) Explain why an acyl chloride is used rather than the carboxylic acid when a high yield is wanted. [3]

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- The acyl chloride reaction goes essentially to **completion** – it is not an equilibrium – because the HCl escapes as a gas and cannot react back; esterification with the acid is reversible and stops at about 65% conversion

Exercise 3.5 (c)

3.5 Ethanoyl chloride, CH_3COCl , reacts with propan-1-ol.

(c) Draw the ester link, and give the systematic name of the ester made from **propanoyl chloride** and **ethanol**. [3]

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(c)

- The ester link is $-\text{C}(=\text{O})-\text{O}-$ drawn with the carbonyl double bond and the single bond to the second oxygen; the ester from propanoyl chloride and ethanol is **ethyl propanoate**

Exercise 3.5 (d)

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(d) The ester in (a) is refluxed with dilute sulfuric acid. Name the two organic products, and explain why an excess of water is used. [3]

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(d)

- **Ethanoic acid** and **propan-1-ol**; acid hydrolysis is reversible, so a large excess of water pushes the equilibrium towards the products